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Blanching peppers using microwaves

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Abstract

Enzymatic reactions are not desirable in ripe fruits and vegetables. They cause losses along transportation, storage and processing. Blanching is a pre-treatment operation whose aim is to inactivate enzymes, and is usually applied before cutting, peeling, and freezing in order to avoid browning and changes in texture. Besides inactivating enzymes such as polyphenoloxidase, peroxidase and pectinase, blanching may induce sensory and chemical changes. The purpose of this work was to evaluate changes in antioxidant activity of *Capsicum annuum* Jalapeño type, when treating with microwaves to inactivate polyphenoloxidase. The whole fresh peppers (85% moisture) were blended until a paste was obtained. Ten grams portions were placed in a glass container and processed in a microwave oven until the inactivation of polyphenoloxidase was reached. Inactivation of the enzyme was confirmed with a spectrophotometric method using catechol as substrate. The processed peppers samples were mixed with 80% ethanol to extract phenolic compounds that were determined by the Folin Ciocalteu method. The antioxidant activity was evaluated using the radical ABTS, as described by Charurin et al (2002). Results showed that phenolic compounds were reduced from 9.6 to 7.6 mg/ g peppers (dry weight basis) and antioxidant activity was enhanced from 29 to 42 µM de trolox/ g peppers (dry weight basis) with thermal microwave blanching. Changes in the content of phenolic compounds were confirmed using high performance liquid chromatography, and the emergence of other phenol derivatives with enhanced antioxidant activity was detected in blanched samples. It may be concluded that blanching Jalapeño peppers with microwaves may induce the formation of derivatives of phenolics with enhanced antioxidant activity.

Keywords: blanching; microwave; antioxidants; jalapeño pepper; phenolics.

1. Introduction

With continuing progress in food sciences, it is reasonable to expect the design of specific processes that would result in food products with special characteristics. Peppers (*Capsicum* spp.) have shown to be

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a source of interesting phytochemicals such as phenolics, flavonoids and capsaicinoids with antioxidant, antimicrobial and pungent properties. Peppers are a source of carotenoids and phenolics correlated with antioxidant activity. On the other hand, enzymatic reactions are not desirable in ripe fruits and vegetables, particularly in peppers since they may cause losses of phytochemicals along transportation, storage and processing. Blanching is a pre-treatment operation whose main objective is to inactivate enzymes, and is usually applied before cutting, peeling, and freezing, in order to avoid browning and changes in texture. Besides inactivating enzymes such as polyphenoloxidase, peroxidase and pectinase, blanching may induce sensory and chemical changes that should be evaluated.

Jalapeño pepper *(Capsicum annuum* L) is a green to dark green vegetable that presents an intense red coloration at its completely mature state. In addition to water, the most important components of Jalapeño pepper are 1.2 % of protein, 5.3% of carbohydrates, 2.3% of fiber, and 0.1% of fat. With regard to mineral content, the most important contribution of this vegetable is potassium with 340 mg / 100 g of fresh product; it also contains 25 mg of calcium, 25 mg of magnesium, 7 mg of sodium, 2 mg of iron, and 0.3 mg of zinc [1].

The increase in the consumption of sliced Jalapeño pepper, the so called “nachos”, has generated an increase in small and medium industries dedicated to their production by fermentation and pickling. Other forms of preserving Jalapeños are refrigeration, freezing, and drying (to produce the so-called “chipotles”) [1].

Generally the first step in fruit and vegetable processing is blanching in order to avoid the production of undesirable flavors and browning. Enzymatic browning is a prominent deteriorative reaction in fruits associated with the increased concentration of polymeric derivatives of *o*-quinones, which derive from phenolic substrates through oxidative reactions catalyzed by polyphenol oxidase, in the presence of atmospheric oxygen. The blanching of peppers is usually performed using hot water or steam. Nevertheless blanching using microwaves reduces heating time, as well as the loss of water soluble nutrients that are leached into the water [2]. Considering that blanching peppers using microwaves may be of importance in the preservation of antioxidant activity of these vegetables, the aim of this work was to evaluate changes in phenolics and antioxidant activity of *Capsicum annuum* Jalapeño type, when treating with microwaves to inactivate polyphenoloxidase.

2. Materials & Methods

Whole fresh peppers (85% moisture) were blended until a paste was obtained. A series of glass containers with 10 g portions were prepared and processed in a microwave oven during 10, 15, 20, 25 and 30 s. The temperature of the surface of the peppers paste was monitored. Inactivation of the enzyme was confirmed with a spectrophotometric method using catechol as substrate. The processed peppers samples were mixed with 80% ethanol to extract phenolic compounds that were determined by Folin Ciocalteu method. The antioxidant activity was evaluated using the radical ABTS, as described by Charurin et al [3].

The samples of fresh and blanched jalapeño were analyzed by HPLC (Varian 920-LC) using a reversed-phase column (4.6 mm, 50 μm, Supelcosil C18) at 27°C and gradient elution with solvent A (Water trifluoracetic, pH 3) and solvent B (Acetonitrile) using the following elution profile: 0-50 min linear gradient from 90% A: 10% B to 55% A: 45% B: linear gradient from 50 -60 min to 40 % A: 60 % B and continuing isocratically at 40% A: 60 % B for 10 additional minutes. Flow rate: 1 mL/min. Injection volume: 20 μL. A group of phenolic standards were previously analyzed by HPLC in order to determine the retention time of each of the standards.

3. Results & Discussion

The time of exposure of the peppers to microwaves necessary to inactivate polyphenoloxidase was of 20 s. However, the time required to reach the inactivation temperature of the enzyme (80ºC or higher) was of 15 s. Therefore, the real time of enzyme inactivation was of five seconds. Results showed that free phenolic compounds were reduced from 9.6 to 7.6 mg/ g peppers (20.8%) in a dry weight basis, however the antioxidant activity of Jalapeño pepper was enhanced from 29 to 42 µM of trolox/ g peppers (dry weight basis) with thermal microwave blanching (see Table 1). This may be attributed to the generation of phenolic derivatives with enhanced antioxidant activity.

Table 1. Antioxidant activity and concentration of free phenolics of chilli pepper "Jalapeño" after microwaves treatment

Treatment time (s)	Antioxidant activity mM Trolox/ g (dry basis)	Free phenolics mg /g (dry basis)
0	29±0.8	9.66±0.09
10	30±0.5	8.96±0.4
20	42±0.9	7.68±0.1

The analysis of the blanched and non-blanched peppers by HPLC in the present work confirmed the reduction or the increase of some phenolics and the appearance of derivatives due to the microwave treatment. The phenolic acids present in Jalapeño pepper were identified by comparing the retention times obtained in the HPLC column to the corresponding retention times of standards previously determined in the same column. The phenolics and retention times were: protocathecuic (5.7 min), *p*-coumaric (15.1 min), *o*-coumaric (20.6 min) and cinnamic (28.7) acids. Catechin (8.73 min) was also present, and the contents of these compounds varied after the blanching process. This may be observed in Figure 1, which shows the chromatographs of phenolics and derivatives profiles, before and after the microwave treatment.

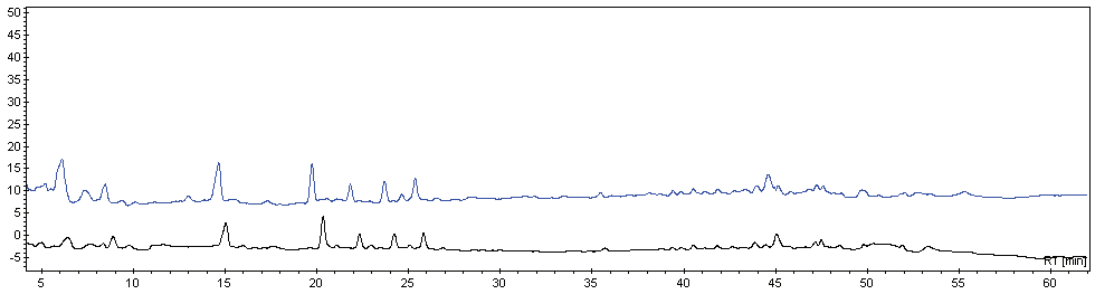

Fig. 1. Phenolics profiles of blanched and non-blanched peppers obtained by HPLC

Ornelas-Paz et al. [4] investigated the effect of cooking on the capsaicinoids and phenolics contents of some Mexican peppers. The total phenolic content in raw peppers varied widely between types of peppers. Moderate losses in capsaicinoids were induced by boiling, while grilling caused a significant increase in the content of these compounds. Boiling and grilling sequentially increased the total phenolic content in pungent peppers. However, total phenolic content in non-pungent bell peppers was reduced by cooking up to 26.9%, a similar reduction to the one obtained in the present work. Materska and Perucka [5] found a high correlation between the content of phenolics and capsaicinoids and the antioxidant activity of four varieties of peppers grown in Poland. The antioxidant activity of feruloyl, sinapoyl, and quercetin glycosides was similar to that of capsaicin and dihydrocapsaicin.

The intensity of microwave energy necessary to inactivate the polyphenoloxidase of jalapeño peppers was calculated as proposed by Ortiz et al. [3] but expressing the time in seconds, as in the following equation:

$$E = \frac{Wt}{m} = \frac{kW\ (s)}{(g)} = \frac{KJ}{g} \tag{1}$$

Where E = energy density KJ/g; kW = kilowatts, which is the microwave oven power; t = time of microwave exposure in seconds; and m = quantity of the sample in grams. The energy value was 0.38 KJ/g, a lower value than the one required to inactivate peroxidase in poblano pepper. This agrees with the fact that peroxidase needs a higher energy to be inactivated than polyphenoloxidase.

Table 2 shows the energy density calculated by us from the results of some published works about the blanching of vegetables using microwaves. It may be seen that the energy density for microwave blanching, varies from 0.15 in strawberries to 2.55 KJ/g in potatoes; depending on the characteristics of the vegetable. The characteristics of each product may be involved in the blanching time and the microwave energy necessary to achieve the inactivation of enzymes, as well as the pH of the sample, the dielectric constant and the loss factor of each specific material.

Some details of the results obtained by several authors presented in Table 2 are discussed as follows. Moreno et al. [7] proved the effect of blanching prior osmotic dehydration on the quality and stability of strawberries. In microwave treated samples well preserved cells were found.

Lin and Brewer [8] studied the effects of microwave blanching prior to freezing as an alternative pretreatment for frozen peas. Four different treatments were applied to the peas: steam, boiling water immersion, microwaves, or microwave-blanched in a bag. All the samples were frozen and evaluated after 0, 6 and 12 weeks for sensory characteristics and peroxidase activity. Both microwave treatments darkened the color of peas. The samples microwave-blanched in a bag were visually greener than other treatments, but their appearance was less intact. The ascorbic acid retention was similar in the four treatments. The two microwave treatments were able to sufficiently inactivate enzymes to a level comparable to the one afforded by conventional blanching.

Olivera et al. [9] subjected Brussels sprouts to blanching by microwaves and then freezing and storing at -18 ºC for months. A significant increase in (-a*) values of the microwave samples was found, compared to fresh Brussels sprouts, increasing the greenness of the product. Also an increase in measured radical scavenging activity (RSA) was found on the microwave blanched samples.

Oerlemans et al. [10] analyzed the thermal degradation of glucosinolates in red cabbage. In this study, the myrosine inactivation was reached by microwaving the red cabbage for 4 and 48 s at 900 W.

Saverini et al. [11] proved combinated treatments of blanching and dehydration in potato cubes. They reported that, in terms of process speed and quality (color and rehydration capability), the best combinations were blanching by microwaves coupled to dehydration on a belt drier.

In 2003, Severini et al. [12] studied the effect of saline solutions in preventing enzymatic browning in sliced potatoes. They found that blanching in sodium-chloride-calcium chloride solutions are demonstrably the best microwave blanching treatment if performed at 600 W for 5 min. This treatment resulted in polyphenoloxidase inactivation, acceptable retention of potato firmness and desirable partial gelatinization.

In 2000, Begum and Brewer [13] studied the effect of microwave blanching on chemical, physical and sensory characteristics of tomatoes. This study demonstrated that even though visual and sensory attributes were highest for boiling water blanched tomatoes, microwave blanched tomatoes retained a higher nutritional value on the finished product.

In 2001, Begum and Brewer analyzed the effect of microwave blanching on snow peas prior to freezing. Microwave blanched in heat sealable bags retained more reduced ascorbic acid (RAA: 72%) than other treatments and had as high or higher sensory appearance, aroma, flavor, texture and generally acceptable scores than others treatments. These results imply that blanching snow peas in a heat-sealable microwave bag prior to frozen storage yields a product of equivalent sensory quality and superior nutritional quality, as compared to other conventional blanching methods.

Table 2. Energy density for microwave blanching calculated from the results reported by several authors

Reference	Commodity	Blanch process	E $\left(\frac{KJ}{g}\right)$
Moreno et al. 2000	Strawberries (whole)	$\frac{0.4\ kW\ (150\ s)}{400\ g}$	0.15
Lin and Brewer 2005	Peas (whole)	$\frac{0.8\ kW\ (240\ s)}{500\ g}$	0.3
Olivera et al. 2008; Viña et al. 2007	Brussels sprouts (leaves)	$\frac{0.4\ kW\ (300\ s)}{250\ g}$	0.84
Oerlemans et al. 2006	Red cabbage (leaves)	$\frac{0.9\ kW\ (288\ s)}{300\ g}$	0.86
Severini et al. 2005	Potato (cubes)	$\frac{0.85\ kW\ (300\ s)}{100\ g}$ $\frac{0.4\ kW\ (150\ s)}{400\ g}$	2.55

4. Conclusion

It may be concluded that blanching of Jalapeño peppers with microwaves may induce changes in the phenolics profile and the formation of derivatives of phenolics with enhanced antioxidant activity.

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